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**Do Adults Undergoing Minimally Invasive Quadriceps-Sparing Total Knee Arthroplasty
Have Less of a Risk of Developing a Postoperative Deep Venous Thrombosis as Compared
to Patients Undergoing a Standard Medial Parapatellar Total Knee Arthroplasty?**

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A SELECTIVE EVIDENCE BASED MEDICINE REVIEW

In Partial Fulfillment of the Requirements For

The Degree of Master of Science

In

Health Sciences - Physician Assistant

Department of Physician Assistant Studies
Philadelphia College of Osteopathic Medicine
Philadelphia, Pennsylvania

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ABSTRACT

OBJECTIVE: The objective of this selective EBM review is to determine whether or not “Do adults undergoing minimally invasive quadriceps-sparing total knee arthroplasty have less of a risk of developing a postoperative deep venous thrombosis as compared to patients undergoing a standard medial parapatellar total knee arthroplasty?”

STUDY DESIGN: A review of one case series published in 2007 and two randomized controlled trials published in 2014.

DATA SOURCES: Primary literature found in PubMed that compared the surgical outcomes of minimally invasive quadriceps-sparing total knee arthroplasty to standard medial parapatellar total knee arthroplasty.

OUTCOME MEASURED: Postoperative deep venous thrombosis development.

RESULTS: All three studies reported that zero patients that received the minimally invasive surgery developed a DVT. In each study, at least one patient that received the standard surgery developed a DVT. In King et al., 4 patients who received the standard medial parapatellar total knee arthroplasty developed a DVT. In both Tasker et al. and Tomek et al. 1 patient who received the standard medial parapatellar total knee arthroplasty developed a DVT.

CONCLUSIONS: Although further research needs to be done to make a general statement, there is some evidence, based on the information in the studies reviewed, that adults undergoing minimally invasive quadriceps-sparing total knee arthroplasty have less of a risk of developing a postoperative deep venous thrombosis as compared to patients undergoing a standard medial parapatellar total knee arthroplasty.

KEY WORDS: DVT, minimally invasive quadriceps-sparing total knee arthroplasty, standard medial parapatellar total knee arthroplasty.

INTRODUCTION

Deep vein thrombosis, or DVT, is a condition where a blood clot develops within a deep vein, most commonly in the lower extremities or pelvis. Common risk factors of DVT development include genetic prothrombotic states, surgery, cigarette smoking, estrogen-containing contraceptives, obesity, and long periods of immobility such as air travel. Physiologically, a DVT can develop when there is venous stasis, hypercoagulability, and/or endothelial injury which lead to inflammation, platelet activation, and eventually clot formation. The clot has the potential to dislodge from the deep vein and travel to the lungs, thus becoming a pulmonary embolism (PE). Blood clots can impede blood flow within the vessel, causing damage to the tissue and organs downstream. When this occurs within the pulmonary vasculature causing a PE, the lungs lose the necessary blood flow needed for their function and death can occur.

Many patients that present with DVT are asymptomatic, but unilateral leg swelling, pain, warmth, and erythema are classic presentations. On physical exam, a patient can present with dilated superficial veins and tenderness along the anatomy of the deep veins. Similarly to DVT, a patient with a PE can present with no symptoms, or with dyspnea, pleuritic chest pain, cough, and symptoms of DVT. Due to the severity of the consequences and possible lack of symptoms, an assessment of the clinical pretest probability can help categorize patients before diagnostic testing is performed. There are many assessments available, but the Wells score is the most commonly used.¹ There are nine components of the Wells score: active cancer (treatment ongoing or within past six months), immobilization of the lower extremities, bedridden for more than three days or major surgery within four weeks, tenderness along deep venous system, entire leg swelling, calf swelling by more than 3 cm when compared to the asymptomatic leg, pitting edema, nonvaricose superficial veins, and alternative diagnosis as likely or more likely than that

of DVT.¹ The first eight components earn the patient one point, whereas the last would deduct two points from the patient's final score.¹ A patient's score of 3 or greater indicates a high probability (50-75%) that the patient has a DVT, 1 or 2 is a moderate probability (17%), and 0 or less is a low probability (3%).¹ The modified Wells score is used if the patient has had a DVT in the past and if the score is 2 or greater, then DVT is likely, and if the score is 1 or less, DVT is unlikely.¹ Patients with a low probability detected with the Wells score then have a D-dimer level taken. If the D-dimer is negative then a DVT is ruled out, but if positive then an ultrasound is performed.¹ The diagnostic test of choice in determining a DVT is venous ultrasound with Doppler.¹ To definitively diagnose a PE, a CT pulmonary angiography has to be performed.²

The treatment of a DVT is anticoagulation, but the length of time for which the patient is anticoagulated depends on the causative factor.³ The treatment of a PE includes anticoagulation, thrombolysis, inferior vena cava filter, or an embolectomy depending on patient's history, presentation, and provider preference.²

Understanding the signs, symptoms, and diagnostic tests in detecting a DVT is very important because in the United States, approximately 1,000,000 people develop a DVT/PE per year.⁴ Each year 100,000-180,000 people within the U.S. die due to a PE and it is the leading cause of preventable death in hospitalized patients.⁵ In addition, every year there are more than 500,000 hospital admissions for DVT/PE and the annual total health care cost for both DVT and PE is around \$2-\$10 billion.^{4,6}

As stated earlier, both surgery and immobilization are risk factors in the development of a DVT. Orthopedic surgeries, in comparison to all other forms of surgery, has the highest risk of postoperative DVT/PE development.⁷ In orthopedic surgeries specifically, increasing age, preexisting cardiovascular disease, and previous thromboembolism are additional risk factors to

developing a clot.⁸ Calfon et al. determined that there is a higher incidence of DVT development of the calf in patients that had orthopedic surgery as compared to those that had general surgery.⁹ DVT development after orthopedic procedures most commonly occurs in the leg that was operated on, suggesting possible venous injury as a mechanism to clot development.⁹

The movement toward the minimally invasive quadriceps sparing approach was initiated due to evidence suggesting that with less manipulation to the soft tissues, post-operative recovery and hospitalization stay is shortened and pain is decreased.¹⁰ The idea being that patients will opt to increase their mobility earlier on post-operatively, thus eliminating immobility as a risk factor in DVT development. This paper evaluates two randomized controlled trials (RCTs) and one case series comparing DVT development post-operatively in patients undergoing minimally invasive quadriceps-sparing total knee arthroplasty and standard medial parapatellar total knee arthroplasty. The difference in surgical approach may increase a patient's risk of developing a postoperative DVT.

OBJECTIVE

The objective of this selective EBM review is to determine whether or not “Do adults undergoing minimally invasive quadriceps-sparing total knee arthroplasty have less of a risk of developing a postoperative deep venous thrombosis as compared to patients undergoing a standard medial parapatellar total knee arthroplasty?”

METHODS

The studies selected for this review encompass two randomized controlled trials and one case series that include patient-oriented evidence that matters, or POEMs. The population includes adults in need of a total knee replacement. The intervention performed is minimally

invasive quadriceps-sparing total knee arthroplasty and the comparison group is those who received the standard medial parapatellar total knee arthroplasty. The outcome measured, or POEM, is postoperative DVT development.

The selected articles were discovered by searching PubMed using the key words “minimally invasive quadriceps-sparing total knee arthroplasty.” Articles were selected based on the inclusion of POEMs and relevant information pertaining to the clinical question. Inclusion criteria was primary literature published in or after 2007 and exclusion criteria were studies that did not directly compare the outcomes of the two surgeries in question. The articles are written in English and published in peer-reviewed journals. The summary of statistics used include relative risk increase, or RRI, absolute risk increase, or ARI, and numbers needed to harm, or NNH.

Table 1 includes the demographics of the studies referred to in this review.

Table 1 - Demographics & Characteristics of included studies

Study	Type	# Pts	Age (yrs)	Inclusion Criteria	Exclusion Criteria	W/D	Interventions
King ¹¹ (2007)	Case Series	145	42-85	One surgeon's previous 50 traditional medial parapatellar approach total knee arthroplasties. The same surgeon's first 100 minimally invasive quadriceps-sparing total knee arthroplasties.	none	0	Quadriceps-sparing total knee arthroplasty
Tasker ¹² (2014)	RCT	102	67.3 ± 8.4, 68.2. ± 7.5	Pts 18-80 years old in need of a unilateral total knee replacement for either osteoarthritis, rheumatoid arthritis, osteonecrosis, or post-traumatic arthritis of the knee.	BMI > 35, active infection, previous open knee surgery on affected side, physiological or neurological impairment likely to impede post-operative rehabilitation, knee flexion < 100 degrees, fixed flexion > 15 degrees, varus or valgus deformity > 15 degrees,	10	Quadriceps-sparing total knee arthroplasty

					immunosuppression, or pregnancy		
Tomek ¹³ (2014)	Double Blind RCT	129	63.7 ± 9.7, 64.8 ± 9.3	Knee osteoarthritis and failure of nonoperative treatment ASA* class 1, 2, or 3, ability & willingness to actively participate in postoperative rehabilitation, ability to walk independently (with or without ambulatory devices) age ≤ 85 yrs.	Valgus or varus deformity >10 (as measured on a weight-bearing long-leg AP alignment radiograph), active knee flexion <95 degrees, pt considering bilateral procedure because of bilateral knee osteoarthritis, bone or ligament deficiency requiring the use of augments or constrained implants, daily preoperative use of narcotic pain medication, prior ipsilateral knee arthroplasty	2	Quadriceps-sparing subvastus technique of total knee arthroplasty

OUTCOMES MEASURED

The outcome measured in the three studies selected is postoperative DVT development which is compared between the two surgeries. King et al. assessed DVT development based on patient symptoms and diagnosed them through venous Doppler and duplex ultrasound.¹¹ Tasker et al. and Tomek et al. measured DVT development by clinician diagnosis.

RESULTS

In the case series written by King et al., the operative logs of one surgeon's previous 50 traditional total knee arthroplasties were compared to the same surgeon's first 100 quadriceps-sparing minimally invasive total knee arthroplasties.¹¹ The patients who received the surgery were adults who suffered from conditions such as osteoarthritis and inflammatory arthritis. In the traditional group, or control group, 5 of the patients were lost to follow up, so only 45 were included in the study.¹¹ In the traditional group, out of the 45 patients that were included in the study, 4 developed a DVT.¹¹ In the minimally invasive group (MIS), out of the 100 patients included in the study, 0 developed a DVT.¹¹

To find the number needed to harm (NNH), the relative risk increase (RRI) and absolute risk increase (ARI) were calculated. The NNH is 12, which suggests that for every 12 patients that undergo the traditional surgery in comparison to the MIS surgery, one more patient will develop a DVT.

Table 2: NNH King et al.

CER	EER	RRI	ARI	NNH
0.0889	0	-1	-0.0889	12

Tasker et al., a RCT, compared the results of MIS and standard total knee arthroplasty (TKA). In this study, candidates were adults in need of knee arthroplasty due to osteoarthritis, rheumatoid arthritis, osteonecrosis, and post-traumatic stress of the knee.¹² Exclusion criteria included patients with a BMI over 35, since these patients are not candidates for MIS.¹² There were 120 patients that consented to participate in the study, 18 were excluded, and 102 were block randomized into either the control surgery, TKA, or the experimental surgery, MIS.¹² There were 48 patients who received the MIS and 54 received the TKA, but several surgeries were performed by a resident which excluded them from analysis.¹² In the end, the outcomes of 46 patients who received MIS and 46 patients who received TKA were analyzed.¹² One patient who received the TKA and no patients who received the MIS, developed a DVT.¹² The RRI, ARI, and NNH were calculated and the results are listed in Table 3.

Table 3: NNH Tasker et al.

CER	EER	RRI	ARI	NNH
0.0217	0	-1	-0.0217	47

The NNH is 47, which suggests that for every 47 patients that undergo TKA in comparison to the MIS surgery, one more patient will develop a DVT.

In the RCT by Tomek et al., 129 patients were randomized to receive either the experimental surgery, the quadriceps sparing (QS) total knee arthroplasty, or the control surgery, the medial parapatellar arthrotomy (MPPA).¹³ The patients included in the study were adults with knee osteoarthritis without prior knee arthroplasty in the affected knee.¹³ Of 129 patients randomized, 66 received the MPPA and 63 received the QS, and one patient from each group was lost to follow up.¹³ Zero patients who received the QS arthroplasty and one patient who received the MPPA developed a DVT.¹³ The RRI, ARI, and NNH are located in Table 4.

Table 4: NNH Tomek et al.

CER	EER	RRI	ARI	NNH
0.0154	0	-1	-0.0154	65

The NNH is 65, which suggests that for every 65 patients that undergo MPPA in comparison to the QS surgery, one more patient will develop a DVT.

DISCUSSION

In the studies discussed, all were comparing a minimally invasive total knee arthroplasty technique to a traditional technique. In total, zero patients that received the minimally invasive surgery developed a DVT, while several patients who received the traditional knee arthroplasty developed a DVT. Although the NNH varied from study to study, the numbers remained relatively low. With a low NNH there is an increased risk of harm (DVT development) with the traditional technique as compared to the minimally invasive technique. The data presented suggests that patients undergoing quadriceps-sparing subvastus total knee arthroplasty are less likely to develop a deep venous thrombosis after surgery as compared to patients undergoing medial parapatellar total knee arthroplasty.

Standard of care for patients undergoing total knee arthroplasties is postoperative DVT prophylaxis. For patients with a low bleeding risk, a 10-14 day pharmacologic prophylactic treatment of low molecular weight heparin (LMW heparin) or direct oral anticoagulants (DOACs), rivaroxaban or apixaban, with or without the use of intermittent pneumatic compression devices is preferred.⁷ For patients with a high bleeding risk, mechanical prophylaxis is indicated over pharmacologic therapy.⁷ Intermittent pneumatic compression devices are the first line prophylactic treatment in patients unable to receive pharmacologic therapy.⁷ The use of a mechanical device as prophylactic therapy is over 50% more effective at preventing DVTs as compared to placebo.⁷ Although pharmacologic therapy is the preferred treatment in preventing DVTs, patients unable to receive medication are safer using a mechanical device than using no prevention at all.

While searching for articles on this subject, no articles were found that primarily focused on DVT development between the two surgeries. Therefore, in the studies reviewed, post-operative DVT development was not the primary outcome of each study. This was the biggest limitation to this research, as there was missing information in each study that could have assisted to make the determining factor of DVT development clearer.

In King et al., it is noted that the patients in both groups received similar treatment for the prophylaxis of DVTs but it is not stated what the exact treatment was.¹¹ Another limitation of this study is that the initial 25 patients selected for the MIS were without significant deformity and were of “approximate height-weight proportionality.”¹¹ The author states that this could possibly make the outcomes seem more favorable for the MIS group over the traditional group.¹¹ There were also differences in the anesthesia used between the two groups; the traditional group received an indwelling epidural catheter while the MIS group received a single shot of spinal

anesthesia.¹¹ The mean operative time was significantly longer only in the first 25 cases of the MIS group as compared to the traditional group, and the authors attribute this to the learning curve of the surgeon.¹¹ Also, patients who received the MIS had a mean hospital stay shorter than those who received the traditional surgery.¹¹ Compiling the limitations of this study, there are significant shortcomings and it is difficult to truly hone in on the causative factor in the DVT development in those that received the traditional surgery.

In the RCT by Tasker et al., one of the limitations of the study is that there is no documentation of what DVT prophylaxis was used. It is stated that “all patients underwent common pre- and post-operative care [..],” but does not describe the care given.¹² Other limitations exist such as two different approaches (mini-midvastus or subvastus) being used in the QS group, although the authors claim that previous evidence suggests similarity between the two approaches.¹² The type of anesthesia used was not congruent among patients, as it was determined by the anesthesiologist.¹² Hospital policy changed during this study and the use of LA infiltration was used in all but 18 patients (including both MIS and TKA patients) and the authors pose that this could be a potential reason for outcome differences.¹² A smaller mean amount of blood loss and a significantly shorter mean readiness for discharge in patients who received the MIS surgery over the traditional approach could be protective factors against DVT development.¹² The authors state that the MIS patients had less systemic complications as compared to the TKA patients and suggest further study into this area.¹² At the end of their conclusion, the authors state that with future research into this question, there is curiosity into the possibility of a systemic inflammatory response being at the root of this issue.¹²

In the RCT by Tomek et al., it is stated that warfarin was used for DVT prophylaxis, “except when individual patient characteristics warranted alternative agents.”¹³ The authors

failed to note how many patients used the alternative agents, what type of surgery these patients underwent, and what the alternative agents were. Fortunately, it was stated that during hospitalization following surgery, all patients used a continuous passive motion machine and compressive devices.¹³ Following both surgeries, physical therapy started on postoperative day one and patients were instructed to walk with supervision at least three times daily, but no record of this was provided.¹³ A possible limitation to the generalization of these results is that most of the patients were Caucasian and well educated.¹³

CONCLUSION

Due to the fact that post-operative DVT development was not the primary outcome in the studies reviewed, it is difficult to make the generalization that the surgery itself is the causative factor. However, it is definitely noteworthy that zero patients that received the minimally invasive quadriceps sparing total knee arthroplasty developed a DVT. There is some evidence that adults undergoing minimally invasive quadriceps-sparing total knee arthroplasty have less of a risk of developing a postoperative deep venous thrombosis as compared to patients undergoing a standard medial parapatellar total knee arthroplasty.

Based on the information gathered in the studies reviewed and the available research online, there is a definite need for a primary research study to be done on this subject. Research needs to include more detailed information regarding a patient's medical history; specifically whether they have a propensity to clot or have a history of DVT/PE. The studies should also include a larger, more diverse patient population with a similar BMI and exact information regarding post-operative care/movement. Future studies that focus primarily on DVT development between the two surgical techniques could save lives and uncover clues in the exact physiologic trigger and development of thromboembolic events following orthopedic surgeries.

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